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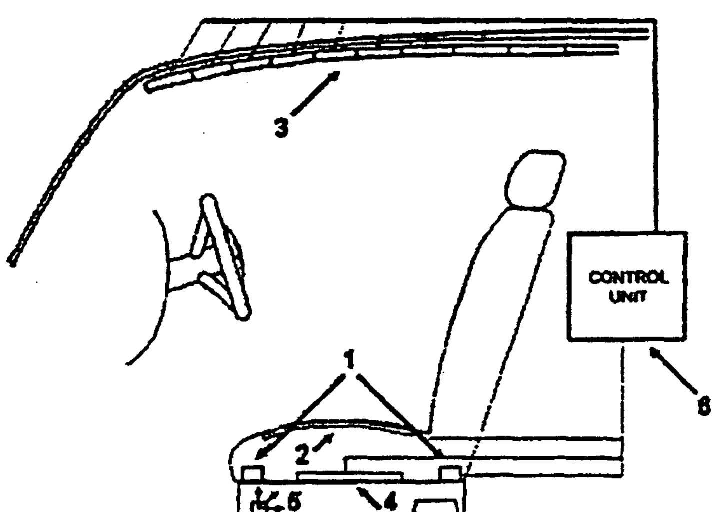
(54) Title: VEHICLE OCCUPANT WEIGHT ESTIMATION APPARATUS

(57) Abstract: This invention describes an occupant size and weight detection device consisting of a combination of force/load sensors (1), a head position sensor (2, 3), a multidirectional acceleration sensor (5), and a seat position sensor (4) used to determine the weight of an occupant based on weight distribution, body angle and foot position. The goal of the invention is to determine the weight of an occupant who is sitting in the front seat of a vehicle that is subjected to the dynamic forces resulting from the vehicle moving. This technology can be used in applications such as automotive occupant weight and position sensing for use with safety devices such as airbags.



1 - weight transducers
2 - first electrode
3 - array of second electrodes
4 - seat position sensor
5 - 3 direction acceleration sensor
6 - control unit

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VEHICLE OCCUPANT WEIGHT ESTIMATION APPARATUS

BACKGROUND OF THE INVENTION

Vehicle occupant protection systems, which are activated in response to a vehicle crash, for the purpose of mitigating occupant injury are well known in the art. A vehicle may contain automatic safety restraint actuators such as front and side air bags, seat belt pretensioners, and deployable knee bolsters. The occupant protection system may further include a collision/crash sensor for sensing the occurrence of a vehicle crash and for providing an electrical signal indicative of the crash severity.

Several known occupant protection systems include an occupant classification or weight detection system. The occupant classification/weight detection system could consist of occupant size or weight determination on force/load sensors, capacitive/electric field sensors, resistive load distribution sensors, ultrasonic sensors, infrared sensors, and/or image based sensors. A controller, which is connected to one or a combination of these sensors, controls the inflatable protection module in response to the sensed size or weight of the occupant. In response to the sensed occupant size or weight, one or more deployment aspects of the air bag may be adjusted. A protection system with adjustable aspects of deployment is commonly referred to as an "adaptive" protection system. Specifically, if the occupant is so small or light that deploying the air bag will not enhance protection of the occupant, it may be desirable to suppress actuation of the occupant protection module. In such a case, deployment may even be more detrimental than no deployment at all.

In any case, the determination of an occupant's size or weight is an important part of adaptive occupant protection systems. There are several types of size classification or weight determination systems. A system that classifies the occupant based on the strength of an electric field (or the capacitance of the human body) may be fooled if a portion of the signal used to excite the sensor is lost. A system that classifies the occupant based on the load distribution, size, shape and/or orientation of the occupant's posterior may not be reliable because varying people of

DESCRIPTION OF THE PREFERRED EMBODIMENT

As Figure 1 shows, the force/load sensors (1) are mounted in the four corners of the seat pan. The first electrode (2) of the head position sensor is mounted in a vehicle seat. The second electrode is an element of the array (3) mounted to the ceiling of the vehicle above the occupant's seat. A seat position sensor (4) is mounted between the seat pan and the supports. A three-direction acceleration sensor (5) is mounted rigidly under the seat. A control unit (6) continuously monitors all of the sensors. The control unit (6) utilizes an excitation method and a synchronous detection method to measure capacity. It uses a micro power low frequency signal that is safe for humans. The resulting weight measurement read by the force/load sensors is biased to account for body angle, foot position and external forces acting on the occupant.

In the preferred system, the force/load transducers measure the weight distribution on the seat pan. A weight is measured on each corner of the seat pan. Figure 2 shows the force/load transducers (1) are mounted on each corner of the seat pan (2), to the seat slide rails (3). These in turn connect to the seat frame. The configuration of these transducers allows the load on each corner of the seat pan to be determined. These sensors give the load distribution of the occupant on the seat, i.e. the forces acting on each corner of the seat pan). The sensors are covered by the seat cushion (4).

The system provides an occupant head position sensor, which utilizes the human body's conductivity, to determine head position by measuring the capacity between the occupant's head and the roof-mounted array of sensors (electrodes). A ceiling-mounted occupant head position sensor may be incorporated in any type of vehicle that has a seat and a roof. Referring to Figure 3, the principal components of the ceiling-mounted proximity sensor of the preferred system are: a set of electrodes mounted in the base portion of the seat; a ceiling-mounted array of second electrodes; a control unit which is connected to both the first and second set of electrodes to provide the necessary measurements and calculations. The seat-mounted electrode provides capacitive connection with the occupant many times greater than the capacity between the occupant's head and the roof-mounted array of electrodes. This connection allows for the consideration that the occupant is coupled

CLAIMS

1. A sensor for detecting the weight of an occupant in a vehicle seat comprising:

At least one load sensor coupled to a seat;

A position sensor determining the position of the occupant in the seat; and

A controller determining the weight of the occupant based upon signals from the at least one load sensor and position sensor.

2. The sensor of Claim 1 wherein the at least one load sensor provides an indication of the load distribution on the vehicle seat.

3. The sensor of Claim 2 wherein the at least one load sensor comprises four weight sensors.

4. The sensor of Claim 1 further including at least one acceleration transducer measuring acceleration, said controller determining the weight of the occupant based upon an acceleration signal from the acceleration transducer.

5. The sensor of Claim 4 wherein the at least one acceleration transducer measures acceleration in three axes.

6. The sensor of Claim one further including a vehicle seatback angle sensor, said controller determining the weight of the occupant based upon a signal from the vehicle seatback angle sensor.

7. The sensor of Claim 1 wherein the position sensor includes a seat electrode providing a connection between the control unit and the occupant's body to transmit an electrical field.

16. The method of Claim 15 wherein said step (d) further includes the step of measuring acceleration in a plurality of axes.

17. A method for determining the weight of an occupant in a vehicle seat including the steps of:

(a) measuring load upon a seating surface;

(b) measuring acceleration; and

(c) determining the weight of the occupant based upon acceleration and the measured load.

18. The method of Claim 17 wherein said step (b) further includes the step of measuring acceleration in a plurality of axes.

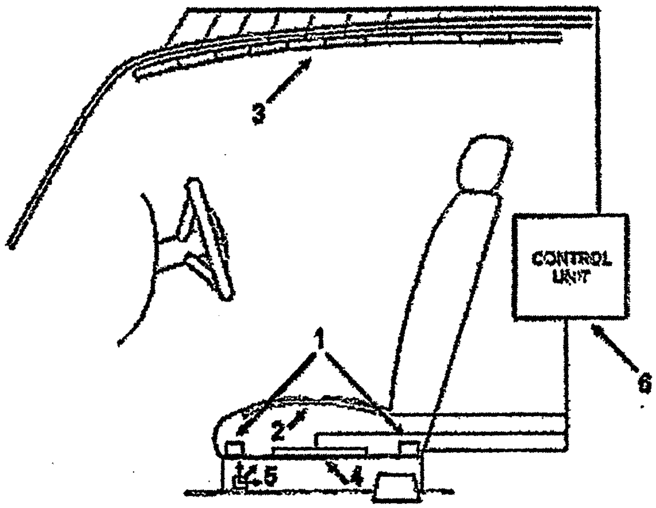

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Figure 1

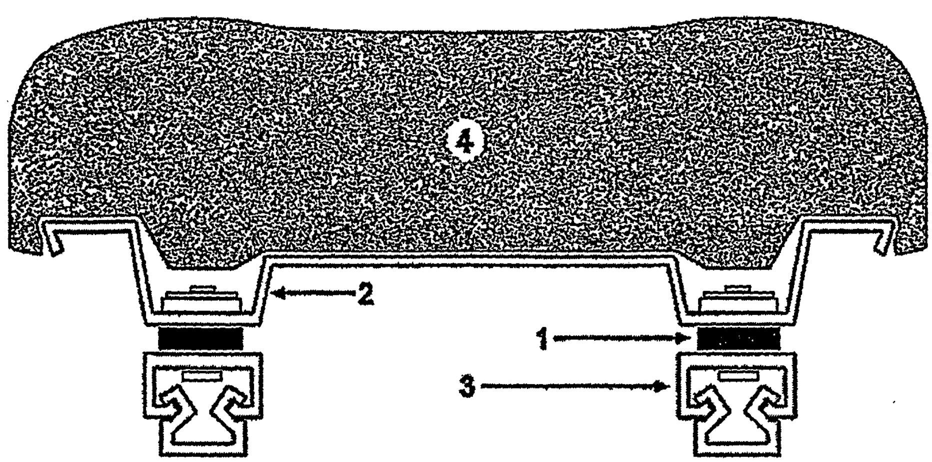

Figure 2

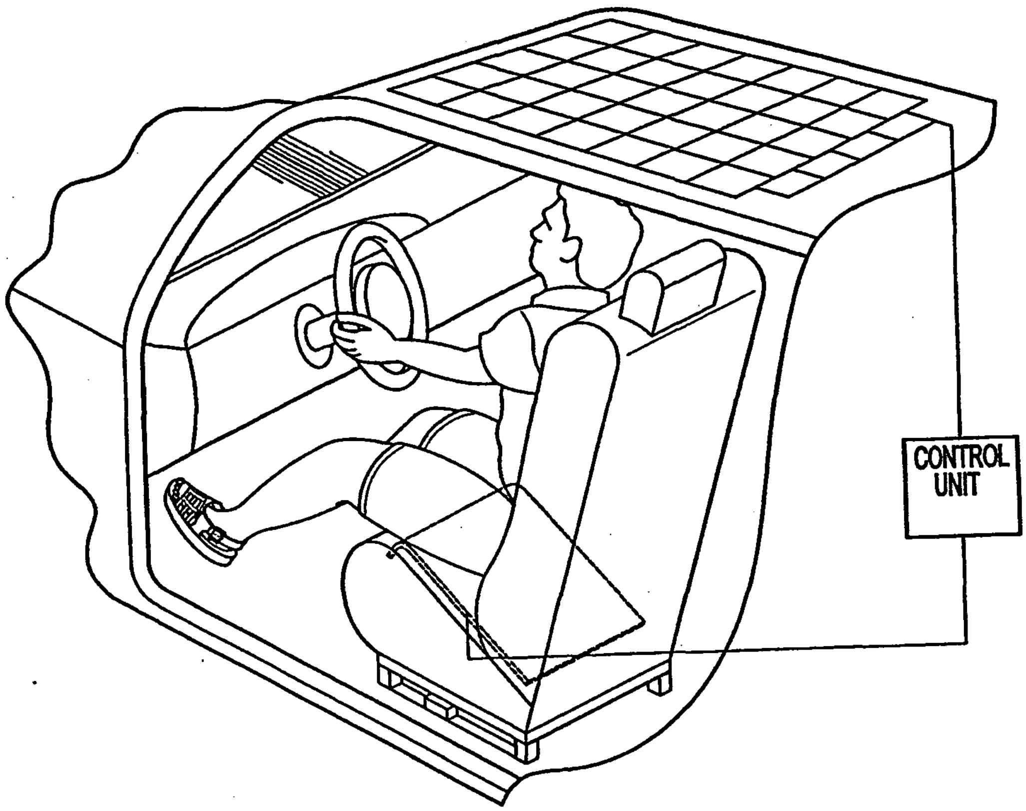

Fig-3

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01G19/414

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 087 598 A (MUNCH CARL A) 11 July 2000 (2000-07-11) abstract column 1, line 66 -column 2, line 8 column 2, line 25 - line 28 column 2, line 39 - line 53; figure 1	1-4,17, 18
Y		6-10, 12-16
Y	US 6 043 736 A (TSURUSHIMA SHINICHIRO ET AL) 28 March 2000 (2000-03-28) column 1, line 54 -column 2, line 2	6,10
Y	WO 97 39920 A (BARRON MICHAEL ;KITHIL PHILIP W (US); ADVANCED SAFETY CONCEPTS INC) 30 October 1997 (1997-10-30) page 7, line 18 -page 8, line 12; figures 3,4	7-9

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA	Authorized officer
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